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# Ubiquitous Mining: The Spatial Patterns of Limestone Quarrying in Late Nineteenth-Century Rhineland

## Introduction and Conceptual Framework

Open-pit mining has altered the earth's surface in significant ways. Operations such as the Anaconda Copper Mine in the US state of Montana or the huge "brown coal" (lignite) fields in Germany frequently come to mind. Their sheer vastness and the associated processing of ores and fossil fuels implies a massive environmental impact.[1] By contrast, the extraction of materials other than precious ores and fuels is rarely noted because it is less spectacular. However, mining for materials that are abundant and common natural resources leaves behind marks on the earth's surface that are no less significant. In fact, gravel, clay, and sand pits, as well as slate, sandstone, limestone, and other quarries are the most ubiquitous form of open-pit resource extraction. While individual pits and quarries are usually smaller in size than ore and coal mines, their agglomeration is in many cases no less impressive and their impact on the environment no less significant. Many regions have been shaped entirely by these allegedly less spectacular mining operations. The reason for the relative "invisibility" of this kind of mining is that its effects are usually not considered to pose a vital environmental threat. Despite the fact that such operations consume land, alter the water table, and intervene in established habitats, they rarely leave behind defunct environments, instead creating lakes, rocks, and non-toxic dumps that are frequently reused by humans, animals, plants, and other organisms.

It is not the intention of this essay to judge whether these changes are for the better or for the worse. Instead it will draw attention to some conditions that have historically shaped these changes and present a tentative framework to reconstruct the emergence of the spatial patterns they left behind. The essay will take the spatial patterns of the pits and quarries, their shapes and regional distribution, as a starting point and

1 Timothy J. LeCain, *Mass Destruction: The Men and Giant Mines that Wired America and Scarred the Planet* (New Brunswick: Rutgers University Press, 2009); Kerstin Kretschmer, *Braunkohle und Umwelt: Zur Geschichte des nordwestsächsischen Kohlenreviers (1900–1945)* (Frankfurt am Main: Lang, 1998); Johann Paul, "Risikodebatten über den Tieftagebau im rheinischen Braunkohlenrevier seit den 1950er Jahren," *Technikgeschichte* 65 (1998): 141–61.

try to explain why these "holes" are in the places they are and why they took the shape they did. This rather narrow perspective will eventually have to be placed in a broader environmental, cultural, and economic context, which I have omitted from this essay for the sake of clarity.

The development of open-pit mines and quarries can best be analyzed by adopting Theodore Schatzki's concept of "practice-arrangement nexuses," which he introduced as an alternative to the nature-culture dichotomy by examining human practices in relation to the physical properties of materials. Citing the example of the construction of a house, Schatzki argues: "Although a house, for instance, is both a human artifact and a social phenomenon, the physical properties of its construction materials . . . are facts of nature."[2] The same can be claimed to be true of the extraction of materials from the earth's surface, i.e., that mining is a "social phenomenon," but also relates to the material properties of the underground terrain as "facts of nature."

Open pits and quarries are therefore the result of human action structured in relation to geological characteristics. The drastic changes of topography and land-use patterns caused by quarries can be best understood as the alteration of "practice-arrangement nexuses." While the existence of underground resources is a necessary precondition for mining that determines where materials can be extracted, the actual spatial patterns of open-pit mining are restrained by an amalgamation of physical and social factors. This is especially true of the more common materials of interest here, since their relatively broad distribution allows for considerable variability in locating mining activities. Schatzki suggests that technological development is the primary factor that brings about change within "practice-arrangement nexuses." However, the development of knowledge and legal practices form another, arguably more important set of determinants shaping the relation between human action and materiality in the transformation of the earth's surface. This essay will therefore concentrate on knowledge relating to exploitation of resources as well as the rights to do so and will analyze how they translate into changes in topography and land-use patterns following the conceptual framework of "practice-arrangement nexuses." This essay cannot provide a comprehensive analysis; instead, it tries to illustrate pathways of interpretation and further investigations.

2 Theodore Schatzki, "Nature and Technology in History," *History and Theory* 42, no. 4 (2003): 85.

## The Case of Limestone Mining in the District of Mettmann

One of the more commonly found materials that humans extract from the earth's surface is limestone. Limestone was already widespread as a sideline product in agricultural economies long before the nineteenth century. During the late nineteenth century, however, some limestone businesses grew in size and became professional operations serving distinctive regional markets. The limited research on limestone mining that exists on the Rüdersorf quarry near Berlin suggests that this operation flourished in close relation to the construction boom in the nearby metropolis.[3] In regions that were not urbanizing, burnt lime became increasingly important in the agricultural business. In the 1840s the chemist Justus von Liebig published on the qualities of burnt lime as a fertilizer.[4] From the 1850s onwards the demand for limestone in the vicinity of industrializing regions such as the Ruhr increased dramatically due to its use in the iron-smelting process.[5]

The limestone quarries that I will focus on in this essay developed in the context of the demand from the iron industry in an area just south of the Ruhr between the cities of Essen, Düsseldorf, and present-day Wuppertal in the district of Mettmann. Large-scale limestone quarrying in the district started in the 1850s in the Neanderthal valley. (The first discovery of *Homo sapiens neanderthalensis* in 1856 was the result of limestone mining activities in the valley.) By 1876 the industry in the district had grown to 59 quarries employing more than six hundred workers.[6] The size of the individual operations varied greatly. Some were not much more than a one-man business, while other entrepreneurs, such as Wilhem Schüler or Johann Friedrich Schürmann, owned several large quarries with up to 30 workers each.[7] In 1887, Schüler and Schürmann merged their operations with those of several other local businessmen and formed the Rheinisch-Westfälische Kalkwerke as a single joint stock company. Their intention

3 Gernot Wittling, "Der Staat als Innovator im Rüdersdorfer Kalkbergbau während der Frühindustrialisierung," in *Vom Bergbau zum Industrierevier: Montandistrikte des 17./18. Jahrhunderts auf dem Weg zur industriellen Produktionsweise des 19. Jahrhunderts*, ed. Ekkehard Westermann (Stuttgart: Steiner, 1995), 113–24.

4 Werner Kasig and Birgit Weiskorn, *Zur Geschichte der deutschen Kalkindustrie und ihrer Organisationen: Forschungsbericht* (Düsseldorf: Beton-Verlag, 1992), 67.

5 Günter von der Gathen, "Kalkindustrie und Eisen- und Stahlindustrie in Nordrhein-Westfalen," (Diss., University of Cologne, 1955).

6 Bericht über die Steinbrüche und Sandgruben im Kreis Mettmann, 30 March 1876, Landesarchiv Nordrhein-Westfalen, Abteilung Rheinland (LANRW), BR 0034, 24.

7 Mayor's office Wülfrath, Nachweisung über die in der Bürgermeisterei Wülfrath belegenen Sandsteingruben und Steinbrüche, February 1876, LANRW, BR 0034, 24.

was to monopolize the local market and serve the growing demand of the iron industry. In fact, the new stock company expanded aggressively up until the eve of the First World War by buying out competitors.[8]

In 1903, however, the steel magnate August Thyssen, who was looking for a cheap alternative source of limestone, founded his own limestone mining company, the Rheinische Kalksteinwerke. In contrast to the businesses of Schüler and Schürmann, Thyssen's Rheinische Kalksteinwerke did not develop out of preexisting local operations but was constructed from nothing in just a few years. Where the Rheinisch-Westfälische Kalkwerke had depended on existing infrastructure, the new competitor was able to build a whole new system, including up-to-date technologies such as electric lighting in the mine and a railroad to connect the newly opened quarries with the Thyssen ironworks in Essen and Duisburg.[9] The competing companies could not have been more different: the locally based and aggressively growing Rheinisch-Westfälische Kalkwerke, and the operations of the Rheinische Kalksteinwerke, built rapidly from scratch and backed by the immense funds of Thyssen's iron and steel production empire. Despite the fierce competition between them, the two companies did not merge until 1997, when both were bought by the Belgian Lhoist company.

Today, there are about ten major limestone quarries in the district that are visible features of the landscape. While most of these have been abandoned along with the many minor quarries, the four largest quarries are still mined today. All these former and current operations are scattered along a winding ribbon of land some 20 kilometers in length. This belt of quarries marks the course of a limestone deposit embedded in the northwestern edge of the Rhenish Massif.[10] However, the quarries themselves, which today vary in size from between about five hundred meters to two kilometers in diameter, actually form a discontinuous and fragmented pattern that leaves large portions of the resource virtually untouched. Two of the historical factors restraining the wholesale extraction of the deposit that resulted in the fragmented patterns shaping the area today will be of special interest in the following parts of this essay.

8 Kasig and Weiskorn, *Zur Geschichte der deutschen Kalkindustrie*, 77; Rheinisch-Westfälische Kalkwerke AG, *Die Geschichte vom Kalk* (Wülfrath, 1978), 38–39.

9 Bundesverband der deutschen Kalksteinindustrie, *Vom Kalk zum Kalkstein* (Wiesbaden, 1963), 18; Rheinische Kalkwerke, *50 Jahre Rheinische Klakwerke Wülfrath: Ein Beitrag zur Geschichte der deutschen Kalkindustrie* (Wülfrath, 1953); *Wülfrather Zeitung*, 27 January 1904.

10 Rudolf Gotthardt, *Karbonatgesteine in Deutschland: Rohstoff, Nutzung, Umwelt* (Düsseldorf: Beton-Verlag, 1996); Hellmut Grabert, *Abriß der Geologie von Nordrhein-Westfalen* (Stuttgart: Schweizerbart, 1998).

## Knowledge of the Underground Terrain

Resources are embedded in broader material structures underground. Of these, the thickness and the physical quality of the layers covering the resource to be mined are of special importance for the emergence of spatial patterns. The spatial distribution of open pits depends in part on the depth of the material and whether the expected gains outweigh the mine spoilage and effort required for extracting it in a given location. However, in order to explain the patterns of open-pit mining one needs to explore how the physical conditions were intertwined with knowledge of these conditions. At the end of the nineteenth century, no systematic corpus of knowledge about the underground terrain of the Mettmann district existed. A thorough geological survey was only started in 1914.[11] Therefore, much of the mining activity simply expanded from points were limestone had already been extracted and followed the shape of the material arrangements underground as they were unveiled in the process of mining. As the pattern of quarries grew denser at the end of the nineteenth century, experienced workers were able to predict the course of the deposits still underground by bringing together knowledge from various quarries.[12] Increasingly, limestone companies also invested in professional exploration by trained geologists.

In an extension of Schatzki's concept of "practice-arrangement nexuses," Verena Winiwarter and Martin Schmid have pointed out the importance of the ways human perceptions of the natural environment shape our interaction with it.[13] In the case of limestone quarrying, perception of the underground terrain gradually changed between the 1880s and the 1910s. While informal local knowledge was the dominant basis of perception as late as the mid-1900s, an alternative means of knowledge production based on the systematic application of scientific methods gained in importance. In 1912 the geologist Wilhelm Wunstorf, regional head of the Prussian Geological Institute, devoted himself to exploring one particular limestone deposit in the Mettmann district. Drawing on numerous probes that were taken and analyzed, the results were assembled into a comprehensive description of the deposit.[14]

11 *Jahrbuch der Königlich Preußischen Geologischen Landesanstalt zu Berlin* 35, no. 2 (1914): 565.
12 Krumm, Dolomitvorkommen am Sandfeld zu Dornap, 1 November 1905, Rheinkalk, Archiv der Liegenschaftsabteilung (RhK), 00, 10a.
13 Martin Schmid and Verena Winiwarter, "Umweltgeschichte als Untersuchung sozionaturaler Schauplätze? Ein Versuch, Johannes Colers 'Oeconomia' umwelthistorisch zu interpretieren," in *Umweltverhalten in Geschichte und Gegenwart*, ed. Thomas Knopf (Tübingen: Attempto, 2008), 158–73.
14 Wilhelm Wunstorf, Bericht über die Untersuchung des Kalksteinvorkommens im Gutsbezirk Haus Schöller, 1912, Archive of the Geologischer Dienst NRW, L3G, 4708/002.

Wunstorf's evaluation was, however, informed by expectations that related to the extraction of the deposit. Even though he captured the overall composition and the arrangement of the material underground according to scientific rules, his conclusions highlighted two features of the underground terrain that were relevant for open-pit mining: the thickness of top soil and the depth of the water table. Both of these factors delimited the extent of the space where it was possible, and above all feasible, to extract the limestone deposit: "There is no doubt that a layer of top soil of less than 2 m will not cause any difficulties in the extraction of the limestone. . . . It can therefore be calculated that limestone can feasibly be extracted from an area of about 20 ha. The second factor for the calculation of the overall dimension of the exploitable deposit is its thickness, in our case the depth above the water table."[15] The assessment of what was possible and feasible was defined in relation to technological practices of the day, of course. While these permitted the removal of a maximum of about two meters of topsoil and restricted the digging to areas above the water table, the geologist was sure that these conditions would change in due course. Regarding topsoil removal, Wunstorf claimed: "It is a safe conclusion that if the limestone industry progresses at the same pace as in previous years, and there is no doubt about this, a topsoil of 3 m thickness will not pose an economic obstacle to the extraction."[16]

Technological and, implicitly, economic conditions clearly framed the spatial patterns of mining activities. Knowledge about the distribution of the material underground was an important form of perception that preconfigured these activities. In fact, this argument can be extended further if one recognizes that knowledge related not only to the mere distribution of the resources, but also to their specific characteristics. Jacob Vogel has recently demonstrated how the perception and the construction of knowledge about the properties of salt shaped the use of that mineral over the past centuries.[17] The same is true for limestone as a resource needed for the process of smelting iron. Certain characteristics of limestone suited it for use in conjunction with certain types of ore. Wunstorf's analysis of the deposit in the district of Mettmann again shows how physical characteristics and purpose-led knowledge production were intertwined: "The chemical analysis of the sample taken shows that the limestone contains 97–98%

15 Ibid. All quotations from German sources have been translated by the author.
16 Ibid.
17 Jakob Vogel, *Ein schillerndes Kristall: Eine Wissensgeschichte des Salzes zwischen Früher Neuzeit und Moderne* (Cologne: Böhlau, 2008).

carbonate lime and, of particular importance, less than 1% sand and clay (silicic acid and clay silicate). The concentration of magnesia and potash is extremely low. This composition is very advantageous and makes the limestone deposit suitable for use in blast furnaces."[18] From the geologist's perspective, the deposit that he had mapped also seemed extremely desirable as a source for extracting limestone.

Thus, as we have seen, the construction of knowledge was not independent of the actual material structure of the underground terrain. Instead, both the social practice of knowledge construction and the factual properties of the deposit—its specific location and its characteristics—have to be understood as interrelated factors in the anthropogenic change of the environment that followed Wunstorf's assertions. On the one hand, the physical exploration of the underground terrain served as the basis from which comprehensive knowledge was extrapolated. On the other hand, this knowledge was streamlined and eventually applied according to the needs of mining, thus creating patterns in which material change of the earth's surface could take place.

## Legal Practices

Constructing knowledge about deposits was only the first layer of social practices that shaped the spatial patterns of the actual exploitation of the limestone deposits in the Mettmann district. Legal practices constituted a second layer that further constricted what shape the mining-related changes in the earth's surface actually took. In contrast to the mining of ores and fuels, limestone quarrying was not governed by any special laws. While a host of materials, such as coal, iron ore, certain minerals, and precious metals, were listed in the Prussian Mining Law of 1865, limestone and other common substances were not included in the regulations.[19] Social practices and factual properties of the underground terrain were again intertwined in "practice-arrangement nexuses" where legal practices diverged depending on the material properties of the resource that was to be extracted.

18 Wunstorf, Bericht.

19 Peter C. Brown, "Mining Legislation, the Consultation Process and the Reform of Mining Law: Their Significance for Company Form in Ruhr Coal Mining in the 19th Century," in Westermann, *Vom Bergbau zum Industrierevier,* 296–316; Wilhelm Westhoff, *Die deutsche Berggesetzgebung: Von den Anfängen bis zur Gegenwart* (Essen: Glückauf, 1977).

This had significant implications. On the one hand, limestone mining operations had to comply with regulations that were on the whole less strict than those put down in the Mining Law of 1865. They were also not subject to supervision by the state mining authorities, but instead were controlled by local authorities.[20] On the other hand, limestone mining companies did not enjoy the right to expropriate land as permitted by the Prussian Mining Law. They therefore had to bargain with landowners who held the titles to the properties under which the deposits lay. For both these reasons, the development of limestone quarries was almost always piecemeal. Each and every new quarry or extension of an old one had to be negotiated anew with the local authorities and with property owners.

From 1871 onwards, the relevant ordinances regulating mining for limestone were enacted and administered independently by the municipalities. The decentralization of authority over quarrying—resulting in the fragmentation of legal practices—was attributed to the fact that the material conditions in the various localities were too diverse to subordinate the extraction of limestone to national legislation.[21] Not only was the state apparently less interested in these more common resources, but the decentralization of the jurisdiction was also justified by pointing out the diversity of local material conditions. In the Mettmann district, most municipalities adopted ordinances that included provisions about the spatial properties of quarries. Slopes of more than 80 degrees were prohibited and the removed topsoil had to be at least six feet away from the edge of the quarry.[22] However, the same ordinances also allowed for considerable deviations from the rule, stating that: "The local police has to make sure that the face of the quarry has a slope that is in accordance with the properties of the material."[23] In practice, this meant that decisions were largely made on a case-by-case basis. While the entrepreneurs in the limestone business (who were often also members of the local political elite) were easily able to influence decisions, their influence ended where adverse physical conditions conflicted with their assumptions about what could be permitted. There are several cases where further exploitation of a deposit was limited by local authorities after public roads had slipped into quarries.

20 Polizei-Verordnung über das Verfahren bei Anlage und Betrieb von Steinbrüchen, Mergel-, Thon-, Lehm-, Kies-, und Sandgruben, 1871, LANRW, BR0034, 24, §1.
21 Letter from the government of Düsseldorf to all district administrators, 29 July 1870, LANRW, BR 007, 24577.
22 Polizei-Verordnung.
23 Ibid., §5.

In such cases, revised regulations could be restrictive not only in terms of permissible mining techniques, but also in terms of spatial development of the operation. Local authorities dictated details such as the direction of further exploitation and the slope that was thought to be necessary to secure the adjacent public roads.[24] Despite frequent accidents that could be easily attributed to the local authorities' laxity, it was generally not deemed necessary to regulate the exploitation of limestone on a national level. The actual mining of limestone, however, was perceived as equally dangerous and as having equally severe effects on the environment as mining for other materials that were included in the Mining Law of 1865.[25] This discrepancy clearly reflected the relative value of the different resources, with limestone having less worth than ores or fuels. In other words, the regulation of mining in Prussia in the nineteenth century was not primarily considered from the perspective of the activity of mining itself, but rather from the material to be mined.

In consequence, practices that evolved within this legal framework were not at all uniform and instead encouraged an individualized handling of mining operations. In a situation where mine owners were relatively powerful and local authorities relatively ignorant, the reference to the variability of material conditions in effect justified a laissez-faire approach.[26] This approach was only modified where the factual properties of the material obviously contradicted the assumptions under which mining operations were approved. This set of practices around the applicability and actual application of legal regulations affected the spatial patterns of open-pit mining for limestone.

These patterns were further reinforced by the necessity to negotiate with landowners. While owners were seldom able to dictate the prices, the relative cost of land did influence the calculation of where mining was feasible. Thus, the spatial pattern of limestone quarrying was to some degree an outgrowth of the local real estate market. More significant, however, were cases in which landowners aspired to become mining entrepreneurs themselves. This was a relatively common strategy pursued by holders of large estates who had both the land and the capital to engage in the business. In

24 District administration of Mettmann, Note, 19 September 1872, LANRW, BR 0007, 24577; Letter from Wolff to the district administration of Mettmann, 12 April 1881, LANRW, BR0034, 24; Mayor of the township Wülfrath, Note, 5 May 1881, LANRW, BR 0034, 24.

25 Letter from the government of Düsseldorf to the district administration of Mettmann, 18 April 1876, LANRW, BR 0007, 24577

26 Letter from the district administration of Mettmann to the government of Düsseldorf, 5 June 1876, LANRW, BR007, 24577.

fact, most of the successful limestone businesses, like those of Schüler and Schürmann, which were eventually consolidated in the Rheinisch-Westfälische Kalkwerke, started out in this way.

The case of Nicolai Müller is a typical example. In 1885 Müller allowed the newly founded Actiengesellschaft Hochdahler Kalk-Industrie to mine his property. At the same time, he was one of the founding shareholders and was able to secure his interest in the operations, which largely took place on land that he continued to own. This situation only changed in 1907, when the Rheinisch-Westfälische Kalkwerke bought out its competitor and also took over the right to exploit Müller's property by making Müller a shareholder of the enlarged Rheinisch-Westfälische Kalkwerke.[27]

What is of interest here are the conditions under which Müller had originally allowed the exploitation of his land in 1885. The contract stated first, "the Hochdahler Kalk-Industrie is obliged to leave the topsoil intact [until mining takes place], removing no more than two *Morgen* of topsoil in advance."[28] Two *Morgen*—about 5,000 square meters—seems to have allowed only for a very modest pace of extension of the quarry. In fact, agreements such as the one between Müller and the Hochdahler Kalk-Industrie further contributed to the fragmented character of the small-scale mining operations in the Mettmann district. The contract also laid out what to do with the land after the mining operation was finished. Preference was given to using the exploited quarries as dumps for topsoil removed elsewhere. However, the mining company could also pay for dumping topsoil on other parts of Müller's premises.[29] Given the fact that the quarries were scattered, the solution of dumping excavated material just at the edge of the quarry was often more economical than moving it to inoperative mines. This was even more sensible since the Hochdahler Kalk-Industrie did not have any responsibility to recultivate the land. The contract with Müller simply stated that "the exploited land and the removed topsoil remain in the property of Müller and shall be returned three years after exploitation."[30] While the ownership of the material was clearly divided between Müller and the Hochdahler Kalk-Industrie, the spatial distribution of the material was not determined by the agreement.

27 Rheinisch-Westfälische Kalkwerke AG, *Die Geschichte vom Kalk,* 41; Note, RhK, 06, 2.
28 Contract between Nicolai Müller and Actiengesellschaft Hochdahler Kalk-Industrie, 28 March 1885, RhK, 06, 2.
29 Ibid.
30 Ibid.

Both types of legal practices, namely the supervision of limestone quarrying by local authorities and the necessity for contractual agreements with land owners, had a decisive impact on the spatial patterns of limestone mining in the Mettmann district. These practices were based on the material properties of the earth and its resources, and they also shaped its transformation. The specific form of the legal organization of limestone mining was held to be appropriate because of the specific material that was to be exploited. Limestone was considered too unimportant and the conditions underground too diverse to set up a rigid legal framework that would uniformly regulate the exploitation of limestone. The result was an extremely fragmented and varied spatial structure of mining operations, with each mine following a distinct set of regulating ordinances and individual contracts.

## Conclusions

Knowledge and legal practices were only two determinants that shaped the spatial patterns of open-pit limestone mining in the Mettmann district, albeit arguably the most important ones. If we follow Schatzki's suggestion of conceptualizing social practices and factual properties of the underground terrain as intertwined factors in our understanding of anthropogenic environmental change, then knowledge and legal practices appear as specific nexuses that are worth exploring in detail. In this essay, I have attempted to show how this approach can be gainfully applied to understand how spatial patterns of limestone mining emerged in the late nineteenth century and subsequently shaped the environmental characteristics of an entire region. On the one hand, social practices related to the material properties of the underground terrain. Even though the practices that shaped mining activities can to some extent be described in constructivist terms, the "facts of nature," as Schatzki has it, appear to be essential, for they remain, in a factual sense, an authoritative point of reference for the social construction of knowledge and legal organization. On the other hand, the social practices that were established in this way also had far-reaching impacts upon these very "facts of nature." Schmid and Winiwarter have reminded us that knowledge about material properties of the environment was eventually transformed into actual physical "work," which resulted in changes not just of perception, but also of the material properties of the environment.[31]

31 Schmid and Winiwarter, "Umweltgeschichte als Untersuchung sozionaturaler Schauplätze?"

The approach presented in this essay is thus helpful in understanding why mining takes on specific forms at different places and times. To explain the emergence of these forms and their specific characteristics, the cultural contexts of social practices are just as important as the material context in which these social practices developed. Only when both factors are considered in conjunction will it be possible to understand why limestone quarries in the Mettmann district are less spectacular and almost "invisible" when compared to the eminent copper mining operations in the USA or the open-pit lignite mines in nearby Rhenish districts.